year in southern Arizona. The Agricultural College of the University of California has worked out a plan for cooperation with this bureau in the study of the relations of rodents to forage production in that state. The Museum of Vertebrate Zoology of the University of California is continually cooperating with the Biological Survey in its technical research relating to birds and mammals. Other universities have been cooperating along certain lines, as in the case of the Universities of Michigan, Wisconsin and Stanford with the Bureau of Fisheries. In some institutions of learning work is being conducted along lines parallel to that of the Bureau of Biological Survey, but without any definite cooperation and in some cases apparently without any definite effort to keep informed as to current work being done in Washington.

The biological surveys of the states covering field studies of the species of birds and mammals and the most characteristic vegetation and their distribution in relation to temperature or life zones, which this bureau has been conducting for many years, have in some instances, as in the case of Oregon and Washington, had local cooperation from state institutions. The bureau will be glad to see much more of this active cooperation developed in the future. Then, whenever a state survey is being conducted, students of the local colleges may have an opportunity for doing field work in the study of birds, mammals and the distribution of plants, thus gaining an insight into the relationships which exist in nature and obtaining a practical knowledge of field methods which have resulted from years of experience. The Biological Survey welcomes cooperation and will be glad to make itself helpful to students and laboratory workers who desire information or suggestions which may be useful in developing their studies.

In the practical handling of economic zoological problems it is interesting to note the close dependence of one specialist on another. The Biological Survey is continually forced to seek aid of the specialists in the Bureau of Entomology, in the Bureau of Animal Husbandry, in the Bureau of Plant Industry, and even in the Bureau of Chemistry. This being the case, it is evident that the college student of narrow viewpoint will be at a disadvantage when getting into professional scientific work.

The foregoing facts touching the work of the Biological Survey are illustrative of the many opportunities for useful research open to the student of birds and mammals. These opportunities form only an exceedingly small fraction of the vast field covered by economic zoology and the necessary attendant technical studies.

In its relations to the public welfare economic zoology is of the most vital and far-reaching importance. Animal life, from its lowliest organisms, among which lurk some of our deadliest foes as well as beneficent friends, to the highest vertebrates, touches and affects our lives and welfare in innumerable ways. It must be studied in all its phases as never before to guard against previously unsuspected or little-known diseases of man and domestic animals, as well as to develop the wealth and ever-increasing variety of products from which we obtain food, medicines, clothing, dyes, ornaments and an endless number of other useful articles. No man can now be considered well informed who has not a general knowledge of economic zoology in its more direct relationships to human life. The scientific investigator finds in the subject the charm of endless variety and of service to mankind.

E. W. Nelson

THE HISTORY OF POISON GASES

The introduction of poison gases by the Germans at Ypres in April, 1915, marked a new era in modern warfare. The popular opinion is that this form of warfare was original with the Germans. Such, however, is not the case. Quoting from an article in the *Candid Quarterly Review*, (4–561), "All they can claim is the inhuman adoption of devices invented in England, and by England rejected as too horrible to be entertained even for use against an enemy." But the use of

poison gases is even of an earlier origin than this article claims.

The first recorded effort to overcome an enemy by the generation of poisonous and suffocating gases seems to have been in the wars of the Athenians and Spartans (431–404 B.C.) when, besieging the cities of Platea and Belium, the Spartans saturated wood with pitch and sulphur and burned it under the walls of these cities in the hope of choking the defenders and rendering the assault less difficult. Similar uses of poisonous gases are recorded during the Middle Ages. In effect they were like our modern stink balls, but were projected by squirts or in bottles after the manner of a hand grenade. The legend is told of Prester John (about the eleventh century), that he stuffed copper figures with explosives and combustible materials which, emitted from the mouths and nostrils of the effigies, played great havoc.

The idea referred to by the writer in the *Candid* is from the pen of the English Lord Dundonald, which appeared in the publication entitled "The Panmure Papers." This is an extremely dull record of an extremely dull person, only rendered interesting by the one portion, concerned with the use of poison gases, which, it is said, "should never have been published at all."

The great Admiral Lord Dundonald—perhaps the ablest sea captain ever known, not even excluding Lord Nelson—was also a man of wide observation, and no mean chemist. He had been struck in 1811 by the deadly character of the fumes of sulphur in Sicily; and, when the Crimean War was being waged, he communicated to the English government, then presided over by Lord Palmerston, a plan for the reduction of Sebastopol by sulphur fumes. The plan was imparted to Lord Panmure and Lord Palmerston, and the way in which it was received is so illustrative of the trickery and treachery of the politician that it is worth while to quote Lord Palmerston's private communication upon it to Lord Panmure:

LORD PALMERSTON TO LORD PANMURE

"HOUSE OF COMMONS, 7th August, 1855

"I agree with you that if Dundonald will go out himself to superintend and direct the execution of his scheme, we ought to accept his offer and try his plan. If it succeeds, it will, as you say, save a great number of English and French lives; if it fails *in his hands*, we shall be exempt from blame, and if we come in for a small share of the ridicule, we can bear it, and the greater part will fall on him. You had best, therefore, make arrangement with him without delay, and with as much secrecy as the nature of things will admit of."

Inasmuch as Lord Dundonald's plans have already been deliberately published by the two persons above named, there can be no harm in now republishing them. They will be found in the first volume of "The Panmure Papers" (pp. 340–342) and are as follows:

"(ENCLOSURE)

"BRIEF PRELIMINARY OBSERVATIONS

"It was observed when viewing the Sulphur Kilns, in July, 1811, that the fumes which escaped in the rude process of extracting the material, though first elevated by heat, soon fell to the ground, destroying all vegetation, and endangering animal life to a great distance, as it was asserted that an ordinance existed prohibiting persons from sleeping within the distance of three miles during the melting season.

"An application of these facts was immediately made to Military and Naval purposes, and after mature consideration, a Memorial was presented on the subject to His Royal Highness the Prince Regent on the 12th of April, 1812, who was graciously pleased to lay it before a Commission, consisting of Lord Keith, Lord Exmouth and General and Colonel Congreve (afterwards Sir William), by whom a favorable report having been given, His Royal Highness was pleased to order that secrecy should be maintained by all parties.

"(Signed) DUNDONALD

"7th August, 1855"

"MEMORANDUM

"Materials required for the expulsion of the Russians from Sebastopol: Experimental trials have shown that about five parts of coke effectually vaporize one part of sulphur. Mixtures for land service, where weight is of importance, may, however, probably be suggested by Professor Faraday, as to operations on shore I have paid little attention. Four or five hundred tons of sulphur and two thousand tons of coke would be sufficient.

"Besides these materials, it would be necessary to have, say, as much bituminous coal, and a couple

of thousand barrels of gas or other tar, for the purpose of masking fortifications to be attacked, or others that flank the assailing positions.

"A quantity of dry firewood, chips, shavings, straw, hay or other such combustible materials, would also be requisite quickly to kindle the fires, which ought to be kept in readiness for the first favourable and steady breeze.

"Dundonald

"7th August, 1855."

"*Note.*—The objects to be accomplished being specially stated the responsibility of their accomplishment ought to rest on those who direct their execution.

"Suppose that the Malakoff and Redan are the objects to be assailed it might be judicious merely to obscure the Redan (by the smoke of coal and tar kindled in 'The Quarries'), so that it could not annoy the Mamelon, where the sulphur fire would be placed to expel the garrison from the Malakoff, which ought to have all the cannon that can be turned towards its ramparts employed in overthrowing its undefended ramparts.

"There is no doubt but that the fumes will envelop all the defenses from the Malakoff to the Barracks, and even to the line of battleship, the Twelve Apostles, at anchor in the harbour.

"The two outer batteries, on each side of the Port, ought to be smoked, sulphured, and blown down by explosion vessels, and their destruction completed by a few ships of war anchored under cover of the smoke."

That was Lord Dundonald's plan in 1855, improperly published in 1908, and by the Germans, who thus learnt it, ruthlessly put into practise in 1915.

Lord Dundonald's memoranda, together with further elucidatory notes, were submitted by the English government of that day to a committee and subsequently to another committee in which Lord Playfair took leading part. These committees, with Lord Dundonald's plans fully and in detail before them, both reported that the plans were perfectly feasible; that the effects expected from them would undoubtedly be produced; but that those effects were so horrible that no honorable combatant could use the means required to produce them. The committee therefore recommended that the scheme should not be adopted; that Lord Dundonald's account of it should be destroyed. How the records were obtained and preserved by those who so improperly published them in 1908 we do not know. Presumably they were found among Lord Panmure's papers. Admiral Lord Dundonald himself was certainly no party to their publication.

Thus it will be seen that the plan which England had rejected as being too horrible for use in warfare has been, through the deplorable conduct of those who somehow obtained and published it, stolen from us by the Germans, and first used against us. That having been done, we cannot choose but retaliate in kind; for when such methods of warfare are used against us we must, for our own protection and that of our soldiers, ourselves use means similar and as efficacious. Such means lie ready to our hand in Admiral Lord Dundonald's plans; and it is to be presumed that they are now worked out and perhaps improved upon by the modern chemists so as to enable us effectually to give back to the Germans as good a gas as they send us.

One of the early, if not the earliest suggestion as to the use of poison gas in shell is found in an article of "Greek Fire," by B. W. Richardson.[1]

He says:

I feel it a duty to state openly and boldly, that if science were to be allowed her full swing, if society would really allow that "all is fair in war," war might be banished at once from the earth as a game which neither subject nor king dare play at. Globes that could distribute liquid fire could distribute also lethal agents, within the breath of which no man, however puissant, could stand and live. From the summit of Primrose Hill, a few hundred engineers, properly prepared, could render Regent's Park, in an incredibly short space of time, utterly uninhabitable; or could make an army of men, that should even fill that space, fall with their arms in their hands, prostrate and helpless as the host of Sennacherib.

The question is, shall these things be? I do not see that humanity should revolt, for would it not be better to destroy a host in Regent's Park by making the men fall as in a mystical sleep, than to let down on them another host to break their bones, tear their limbs asunder and gouge out their entrails with three-cornered pikes; leaving a vast majority undead, and writhing for hours in torments of the damned? I conceive, for one, that science would be blessed in spreading her wings on the blast, and breathing into the face of a desperate horde of men prolonged sleep—for it need not necessarily be a death—which they could not

[1] *Popular Science Review*, 3, 176, 1864.

grapple with, and which would yield them up with their implements of murder to an enemy that in the immensity of its power could afford to be merciful as Heaven.

The question is, shall these things be? I think they must be. By what compact can they be stopped? It were improbable that any congress of nations could agree on any code regulating means of destruction: but if it did, it were useless; for science becomes more powerful as she concentrates her forces in the hands of units, so that a nation could only act, by the absolute and individual assent of each of her representatives. Assume, then, that France shall lay war to England, and by superior force of men should place immense hosts, well armed, on English soil. Is it probable that the units would rest in peace and allow sheer brute force to win its way to empire? Or put English troops on French soil, and reverse the question?

To conclude. War has, at this moment, reached, in its details, such an extravagance of horror and cruelty, that it can not be made worse by any art, and can only be made more merciful by being rendered more terribly energetic. Who that had to die from a blow would not rather place his head under Nasmyth's hammer, than submit it to a drummer-boy armed with a ferrule?

The *Army and Navy Register* of May 29, 1915, reports that

among the recommendations forwarded to the Board of Ordnance and Fortifications there may be found many suggestions in favor of the asphyxiation process, mostly by the employment of gases contained in bombs to be thrown within the lines of the foe, with varying effects from peaceful slumber to instant death. One ingenious person suggested a bomb laden to its full capacity with snuff, which should be so evenly and thoroughly distributed that the enemy would be convulsed with sneezing, and in this period of paroxysm it would be possible to creep up on him and capture him in the throes of the convulsion.

That the use of poison gases was not new in the minds of military men follows logically from the fact that at the Hague Conference in 1899, the governments represented—and all the warring powers of the present great conflict were represented—pledged themselves not to use any projectiles whose only object was to give out suffocating or poisonous gases. At the Congress of 1907, article 23 of the rules adopted for war on land states:

It is expressly forbidden (*a*), to employ poisons or poisonous weapons.

Before the war suffocating cartridges were shot from the cartridge-throwing rifle of 26 mm. These cartridges were charged with ethyl bromoacetate, a slightly suffocating and non-toxic lachrymator. They were intended for attack on the flanking works of permanent fortifications, flanking casements or caponiers, into which they tried to make these cartridges penetrate by the narrow slits of the loopholes. The men who were serving the machine guns or the cannon of the flanking works would have been bothered by the vapor from the ethyl bromoacetate, and the assailant would have profited by their disturbance to get past the obstacle presented by the fortification. The employment of these devices, not entailing death, did not contravene the Hague conventions.

The only memorable operations in the course of which these devices were used before the war was the attack on the Bonnet gang at Choisy-le-roi.

In the war of the trenches there has been an abuse in the employment of these suffocating cartridges; an abuse because the small quantity of liquid that they contain, about 19 cubic centimeters, can produce no effect on a terrain without cover.

In connection with the suggested use of sulphur dioxide by Lord Dundonald and the proposed use of poisonous gases in shell, the following description of a charcoal respirator by Dr. J. Stanhouse,[2] communicated by Dr. George Wilson is of interest.

Dr. Wilson commenced by stating, that having read with much interest the account of Dr. Stenhouse's researches on the deodorizing and disinfecting properties of charcoal, and the application of these to the construction of a new and important kind of respirator, he had requested the accomplished chemist to send one of his instruments for exhibition to the society, which he had kindly done. Two of the instruments were now on the table, differing, however, so slightly in construction, that it would be sufficient to explain

[2] *Trans. Royal Scottish Soc. Arts*, 4, Appendix O, 198, 1854.

the arrangement of one of them. Externally, it had the appearance of a small fencing-mask of wire gauze, covering the face from the chin upwards to the bridge of the nose, but leaving the eyes and forehead free. It consisted, essentially, of two plates of wire gauze, separated from each other by a space of about one fourth or one eighth of an inch, so as to form a small cage filled with small fragments of charcoal. The frame of the cage was of copper, but the edges were made of soft lead, and were lined with velvet, so as to admit of their being made to fit the cheeks tightly and inclose the mouth and nostrils. By this arrangement, no air could enter the lungs without passing through the wire gauze and traversing the charcoal. An aperture is provided with a screw or sliding valve for the removal and replenishment of the contents of the cage, which consist of the siftings or riddlings of the lighter kinds of wood charcoal. The apparatus is attached to the face by an elastic band passing over the crown of the head and strings tying behind, as in the case of the ordinary respirator. The important agent in this instrument is the charcoal, which has so remarkable a power of absorbing and destroying irritating and otherwise irrespirable and poisonous gases or vapors that, armed with the respirator, spirits of hartshorn, sulphuretted hydrogen, hydrosulphuret of ammonia and chlorine may be breathed through it with impunity, though but slightly diluted with air. This result, first obtained by Dr. Stenhouse, has been verified by those who have repeated the trial, among others by Dr. Wilson, who has tried the vapors named above on himself and four of his pupils, who have breathed them with impunity. The explanation of this remarkable property of charcoal is two-fold. It has long been known to possess the power of condensing into its pores gases and vapors, so that if freshly prepared and exposed to these, it absorbs and retains them. But it has scarcely been suspected till recently, when Dr. Stenhouse pointed out the fact, that if charcoal be allowed to absorb simultaneously such gases as sulphuretted hydrogen and air, the oxygen of this absorbed and condensed air rapidly oxidizes and destroys the accompanying gas. So marked is this action, that if dead animals be imbedded in a layer of charcoal a few inches deep, instead of being prevented from decaying as it has hitherto been supposed that they would be by the supposed antiseptic powers of the charcoal, they are found by Dr. Stenhouse to decay much faster, whilst at the same time, no offensive effluvia are evolved. The deodorizing powers of charcoal are thus established in a way they never have been before; but at the same time it is shown that the addition of charcoal to sewage refuse lessens its agricultural value contemporaneously with the lessening of odor. From these observations, which have been fully verified, it appears that by strewing charcoal coarsely powdered to the extent of a few inches, over church-yards, or by placing it inside the coffins of the dead, the escape of noisome and poisonous exhalations may be totally prevented. The charcoal respirator embodies this important discovery. It is certain that many of the miasma, malaria and infectious matters which propagate disease in the human subjects, enter the body by the lungs, and impregnating the blood there, are carried with it throughout the entire body, which they thus poison. These miasma are either gases and vapors or bodies which, like fine light dust, are readily carried through the air; moreover, they are readily destroyed by oxidizing agents, which convert them into harmless, or at least non-poisonous substances, such as water, carbonic acid and nitrogen. There is every reason, therefore, for believing that charcoal will oxidize and destroy such miasma as effectually as it does sulphuretted hydrogen or hydrosulphuret of ammonia, and thus prevent their reaching and poisoning the blood. The intention accordingly is that those who are exposed to noxious vapors, or compelled to breathe infected atmospheres, shall wear the charcoal respirator, with a view to arrest and destroy the volatile poisons contained in these. Some of the non-obvious applications of the respirator were then referred to:

1. Certain of the large chemical manufacturers in London are now supplying their workmen with the charcoal respirators as a protection against the more irritating vapors to which they are exposed.

2. Many deaths have occurred among those employed to explore the large drains and sewers of London from exposure to sulphuretted hydrogen, etc. It may be asserted with confidence that fatal results from exposure to the drainage gases will cease as soon as the respirator is brought into use.

3. In districts such as the Campagna of Rome, where malaria prevails and to travel during night or to sleep in which is certainly followed by an attack of dangerous and often fatal ague, the wearing of the respirator even for a few hours may be expected to render the marsh poison harmless.

4. Those, who as clergymen, physicians or legal advisers, have to attend the sick-beds of sufferers from infectious disorders, may, on occasion, avail themselves of the protection afforded by Dr. Stenhouse's instrument during their intercourse with the sick.

5. The longing for a short and decisive war has led to the invention of "a suffocating bomb-shell," which on bursting, spreads far and wide an irrespirable or poisonous vapor; one of the liquids proposed for the shell is the strongest ammonia, and against this it is believed that the charcoal respirator may defend our soldiers. As likely to serve this end, it is at present before the Board of Ordnance.

Dr. Wilson stated, in conclusion, that Dr. Stenhouse had no interest but a scientific one in the success of the respirators. He had declined to patent them, and desired only to apply his remarkable discoveries to the abatement of disease and death. Charcoal had long been used in filters to render poisonous water wholesome; it was now to be employed to filter poisonous air.

CLARENCE J. WEST
CHEMICAL WARFARE SERVICE

DUTY FREE SUPPLIES

THE interest in duty-free material has changed to some extent since 1914 because of the impossibility since that time of importing materials from the Central Powers, the former source of supply. During the war some American firms have turned elsewhere, because our European Allies were not in a position to meet the demand.

When the duty-free law was passed, provision was made for the importation without tariff of materials for educational institutions and those engaged in scientific research. The purpose of this law, of course, was to give these institutions the advantage of anything that was made in foreign countries and thus American scientists and the country as a whole were enabled to receive the benefit of foreign endeavor as far as possible. This was a means of promoting knowledge and in the early days of scientific production was certainly of great benefit to this country, but it also had ill effects as by-products. Scientific materials were used in large quantities and though there was demand enough, it was difficult for a business to succeed in this country where labor is paid at a higher schedule than abroad. Consequently, many lines of supplies which were used in considerable quantities were almost exclusively imported from foreign countries. Of course, it is true that these supplies, from a financial standpoint, were of very little importance as far as the country at large is concerned, because the values concerned amount to only a few million dollars annually.

But it must be recognized that we learn to make things by actual experience, and if one produces scientific apparatus and produces it in an efficient and satisfactory manner, he is able consequently to produce a related thing for which there might be a critical need. For instance: when the war broke out and the importations from the Central Powers ceased, this country found itself almost entirely without optical glass. The optical glass used in scientific institutions had been imported and everything went along quite normally in peace times but with the outbreak of the war optical glass became a vital necessity, for one might say there is no instrument of defense which is not connected in some way with optical glass, ranging all the way from telescopes and field-glasses to eyeglasses. The country that can not produce such things satisfactorily and cheaply in an emergency is certainly greatly handicapped in providing defense. We all know of the consternation caused in this country in April, 1917, as the seriousness of the situation dawned upon the government and the public, when it was discovered that no optical glass, broadly speaking, was available for war work, the supply of foreign glass having been exhausted. Perhaps in a minor way this same state of affairs occurred in almost every other industry of scientific nature in this country. One need only consider the difficulty in securing such instruments as polariscopes and microscopes to realize the scarcity that is bound to exist where any one country is dependent upon another for absolutely necessary supplies.

Therefore it is certainly true that the na-